UNITED STATES OF AMERICA

TO WHOM IT MAY CONCERN:

BE IT KNOWN THAT Sabino IACOCCA

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has invented certain new and useful improvements in and relating to: "A centrifugal pump, particularly for electrical household appliances and the like" of which the following is a specification.

DESCRIPTION

The present invention relates in general to pumps, particularly for use in electrical household appliances and the like.

More specifically, the invention relates to a centrifugal pump of the type comprising

a support casing including a body and a volute which are coupled to one another to define a working chamber,

a synchronous electrical motor driven by alternating current, having a stator which is stationary relative to the body, and having a permanent magnet rotor which is rotatable in the body, and

a bladed impeller mounted rotatably in the working chamber and provided with a hub which has a cavity; the impeller being coupled to an end of the rotor which extends into the cavity of the hub of the impeller;

said end of the rotor and the hub of the impeller being provided with a first and a second transverse coupling formation, respectively, which have respective angular extensions which are predetermined in such a manner that there is angular play, suitable for promoting the starting of the motor, between the rotor and the hub of the impeller; the formations being capable of interfering with one another, after the motor has started, in order to bring about the drive of the impeller by the rotor;

the portions of the coupling formation of the rotor that are to cooperate with the coupling formation of the impeller being produced from a resilient material.

A centrifugal pump of that type is described, for example, in European patent EP-0 207 430-B1. In one embodiment which is illustrated, in particular, in Figure 13 of that document, the coupling formation of the rotor is constituted by a curved region of resilient material, the radially outermost surface of which has toothing. This region of

resilient material is inserted axially into an annular cavity in the rotor, the radially outermost surface of which is provided with corresponding toothing. This solution requires an accurate construction of the resilient region and of the corresponding toothing of the rotor. The insertion of the resilient region into the rotor requires fairly precise relative angular positioning in order to prevent interference during insertion. In addition, the resilient region is not constrained in a stable manner on the rotor, in particular in the axial direction.

In an alternative solution described in European patent EP-0 287 984-B1, a quantity of viscous fluid, such as an oil or a grease having lubricating properties, is placed and sealed in the cavity of the impeller hub and is intended to damp the impact between the coupling formations of the impeller and of the rotor and to muffle the noise correspondingly generated. This solution is difficult to put into practice and presents problems from the point of view of maintaining the sealed isolation of the viscous fluid in the cavity of the impeller.

The object of the present invention is to propose an alternative construction which enables the disadvantages outlined above of the solutions according to the prior art to be overcome.

That and other objects are achieved according to the invention with a centrifugal pump of the type specified above, characterized in that the coupling formation of the rotor comprises

a substantially radial transverse appendage which extends from and is integral with a drive body of substantially rigid material which is secured to the rotor, and

a damping formation which is moulded in a single piece of resilient material onto the drive body and has two end

portions which are moulded onto the opposite surfaces or faces of the appendage and which are to cooperate with the coupling formation of the impeller, and also an intermediate connecting and retaining portion which interconnects the end portions and extends at least partially through the drive body in such a manner that the damping formation is constrained in a stable manner, axially and angularly, on the drive body.

Further characteristics and advantages of the invention will emerge from the following detailed description which is given purely by way of non-limiting example with reference to the appended drawings in which:

Figure 1 is a view in axial section of a centrifugal pump according to the invention;

Figure 2 is a plan view from below of the impeller of the pump according to Figure 1;

Figures 3 and 4 are views sectioned on the lines III-III and IV-IV, respectively, of Figure 2;

Figure 5a is a perspective view showing a drive body contained in the pump according to Figure 1;

Figure 5b is a perspective view of the drive body according to Figure 5a, provided with a damping formation of resilient material;

Figures 6 and 7 are plan views in the direction of the arrow VI and the arrow VII, respectively, of Figure 5b;

Figures 8 and 9 are views sectioned on the line VIII-VIII and the line IX-IX, respectively, of Figure 7;

Figure 10 is a partial view in axial section of another centrifugal pump according to the invention;

Figure 11 is a partial perspective view showing a drive body contained in the pump according to Figure 10;

Figure 12 is a view in lateral elevation in the direction of the arrow XII of Figure 11; and

Figures 13 and 14 are views sectioned on the line XIII-XIII and the line XIV-XIV, respectively, of Figure 11.

In Figure 1, a centrifugal pump according to the

invention is generally indicated 1.

In a manner known *per se*, the pump 1 comprises a support casing including a shaped body 2 and a volute 3 (illustrated with broken lines) which are coupled to one another to define a working chamber 4.

The volute 3 forms an axial suction passage 3a and a lateral outlet or delivery passage 3b.

The pump 1 comprises a synchronous electrical motor driven by alternating current and generally indicated 5. In a manner known *per se*, the motor 5 comprises a stator 6 which is stationary relative to the body 2, and a permanent magnet rotor 7 mounted rotatably in that body.

In the embodiment illustrated by way of example, the body 2 forms a central cylindrical chamber 8 in which the rotor 7 of the electrical motor 5 is rotatably accommodated. The rotor has a central shaft 9, the upper and lower ends of which extend rotatably in corresponding supports 10 and 11 which are mounted in the chamber 8 of the body 2 with the interposition of respective toric sealing rings 12 and 13.

The upper end 9a of the shaft 9 of the rotor 7 extends as far as into the working chamber 4, passing through an annular lip seal 14 which is clasped between the upper support 10 and an upper separating element 15 which is substantially in the shape of a crater.

The pump 1 also comprises a bladed impeller 16 mounted rotatably in the working chamber 4 and coupled to the upper end 9a of the rotor 9 of the electrical motor 5.

As shown more clearly in Figures 2 to 4, in the embodiment illustrated the impeller 16 has a central hub 17 which is substantially in the form of a bell and from which extend

externally four radial blades 18 which are equally spaced in an angular manner.

The hub 17 of the impeller 16 has a cavity 19, the mouth 20 of which faces the electrical motor 5. At this mouth, the hub 17 of the impeller 16 has a circumferential bulge 20a (see in particular Figures 3 and 4) which, together with an annular shoulder 21, defines an annular seat 22 into which a closing element 23 is snapped in the form of an annular disc (Figure 1) through which the end 9a of the rotor shaft 9 extends, with the interposition of a toric sealing ring 24.

The closing element 23 is fixed for rotation with the impeller 16 whereas it is rotatable relative to the shaft 9 of the rotor 7.

The end portion 9a of the shaft 9 that extends into the cavity 19 of the impeller 16 is forced with interference into an axial passage 25 defined in a drive body 26 formed from a substantially rigid material, for example polypropylene charged with glass fibres to an extent of from 20% to 40% and preferably of approximately 30%.

The drive body 26 can be seen in particular in Figures 5 to 9.

In the embodiment illustrated by way of example in those Figures, the body 26 comprises a substantially tubular portion 27 in which the passage 25 is formed and at one end of which an integral circumferential annular projection 28 is formed.

As shown in particular in Figure 5a, the drive body 26 has a substantially radial integral transverse appendage 30. In the embodiment according to Figures 5 to 9, the appendage is substantially in the form of an inverted L, with a first and a second limb 30a and 30b (Figures 5a and 9) which are

connected to the tubular portion 27 and to the annular projection 28, respectively.

A notch 31 (Figure 5a) is defined between the two limbs 30a and 30b of the appendage 30.

A slot 32, which extends angularly beyond the opposite lateral surfaces or faces 30c and 30d of the appendage, is formed adjacent to the appendage 30, in the annular projection 28 of the drive body 26.

The slot 32 has an angular extension of, for example, approximately 90°. On the other hand, the appendage 30 has an angular extension α (Figure 6) of advantageously from 25° to 55° and preferably of approximately 40°.

A damping formation of resilient material 35 is moulded in a single piece onto the drive body 26 and, in particular, onto the transverse appendage 30 thereof (see in particular Figures 5b and 6). The damping formation 35 has two end portions 35a and 35b moulded onto the opposite surfaces or faces 30c and 30d of the appendage 30, and an intermediate connecting and retaining portion 35c (see Figures 7 to 9) which interconnects the end portions 35a and 35b, and which extends in the slot 32 and in the passage defined by the notch 31 of the appendage 30.

Advantageously, as shown in Figure 6, the end portions 35a and 35b of the damping formation 35 have respective angular extensions β and γ which are equal to one another and which are preferably also equal to the angular extension α of the appendage 30 contained between them. In particular, the end portions of the damping formation likewise advantageously have an angular extension of from 25° to 55° and preferably of approximately 40°.

The monolithic damping formation 35 is constrained in a

stable manner, both axially and angularly, on the drive body 26.

As a whole, the appendage 30 of the body 26 and the associated end portions 35a and 35b of the damping formation 35 constitute a transverse coupling formation which is generally indicated 40 in Figure 5b and the following Figures and which is to cooperate operatively with a coupling formation produced in the cavity of the hub 17 of the bladed impeller 16.

With reference to Figures 2 to 4, a coupling formation 41 in the form of an angular sector having an extension δ (Figure 2), which is advantageously from 45° to 75° and is preferably approximately 60°, is produced in the cavity 19 of the hub 17 of the impeller 16.

The coupling formations 40 of the rotor of the electrical motor and 41 of the impeller are produced in such a manner that an angular play is defined between the rotor and the hub of the impeller and is capable, in a manner known *per se*, of promoting the starting of the electrical motor 5 which, as is well known, generates, on starting, an extremely low couple, as a result of which it has to be started substantially without load. The coupling formations 40 and 41 are also capable of interfering with one another after the starting of the synchronous electrical motor 5 to bring about the drive of the impeller 16 by the rotor 7 of the motor.

When the electrical motor 5 is supplied with alternating voltage, it is equally possible for it to start in the one or the other direction of rotation. However, this is unimportant because the pump 1 is of the centrifugal type. If in the initial direction of rotation the rotor 7 of the motor 5 has to overcome an excessive resisting torque, the direction of rotation is reversed and then, as soon as the

coupling formation 40, which is int gral with the rotor, strikes against the formation 41 of the impeller, the impeller is driven in rotation. The end portions 35a and 35b of the damping formation 35 ensure that the impact is damped and that the noise generated as a result of that impact is efficiently reduced.

The damping formation 35 is advantageously produced, for example, from a thermoplastic rubber.

Figures 10 to 14 show a variant.

In those Figures, parts and elements which have already been described above have again been given the same alphanumerical symbols for identification.

In the variant according to Figures 10 to 14, the appendage 30 of the drive body 26, which is integral with the rotor of the electrical motor, and the end portions 35a, 35b of the damping formation 35 have, on the side remote from the annular projection 28, respective terminal surfaces 30e and 35e which are inclined relative to the axis of the drive body 26. As a whole, those terminal surfaces 30e and 35e form a surface portion which is substantially conical and convex.

The inclination of the terminal surfaces 30e and 35e relative to the axis of the drive body 26 is advantageously from 30° to 60° and is preferably approximately 45°.

Tests and simulations carried out by and on behalf of the Applicant have indicated that the coupling formation 40 produced as described above with reference to Figures 11 to 14 has, in operation, a better distribution of stresses, in particular in the end portions 35a and 35b of the damping formation 35.

Naturally, the principle of th invention remaining the same, the forms of embodiment and details of construction may be varied widely with respect to those described and illustrated purely by way of non-limiting example, the invention extending to all embodiments that achieve the same benefits, thanks to the same innovative concepts.